2, 3, 4, etc., denote the hours of the day, beginning at 1 A. M. The points of the curve are at the half-hours; thus the first point marked by figures is at half an hour after midnight, or at 12:30 A. M.; the next at one hour afterward.

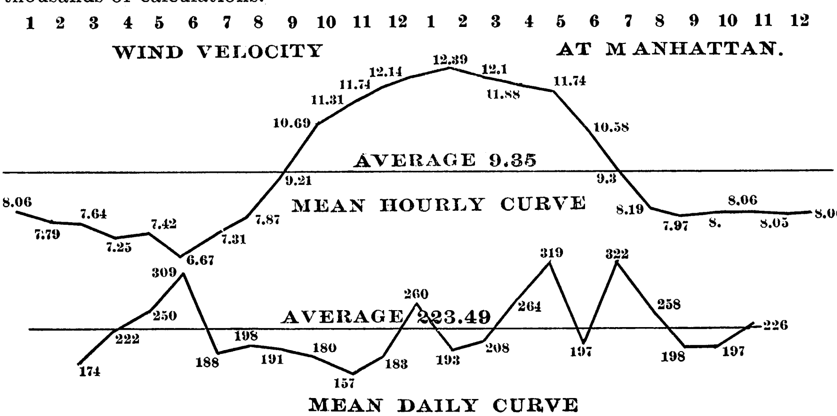
The lowest velocity occurs at about half-past five in the morning, and is 6.67 miles per hour at this time. There is a gradual increase until half-past one in the afternoon, when the maximum — 12.39 miles per hour — is reached. From this time until half past seven in the evening a gradual decrease occurs, from which time until about half-past seven in the morning the wind is almost constant. The average hourly velocity at different stations is as follows. The rates for all places excepting Manhattan and Lawrence, Kansas, are taken from Loomis's Meteorology.

Manhattan	9.35	New Orleans	8.00	London, Eng.	10.00
Lawrence	15.30	San Francisco	9.00	Madras, India	7.00
New York	11.00	Liverpool, Eng.	13.00	Cape of Good Hope	17.00
Chicago	8.00				

The highest velocity that has been recorded was at 6:30 P. M., April 8, 1890, and was sixty miles per hour. It blew at this rate for about ten minutes. The highest record for a whole hour is fifty miles, on the same evening.

The lower curve shows the mean daily velocity for the different months. Beginning with February, 1889, the velocity is shown for each consecutive month up to November, 1890. The figures do not show the exact velocities, but are the nearest whole number. The total number of miles of wind that passed during any month may be found by multiplying the mean daily velocity of that month by the number of days in the month. The lowest velocity was in October, 1889, being 157 miles; the highest in June, 1890, being 322 miles. The highest daily velocity that has been recorded for a single day was 710 miles, on April 11, 1890. The average daily velocity is 223.49 miles, which gives an average hourly velocity of 9.31 miles. This very nearly agrees with the average of the upper curve, the discrepancy being accounted for by the fact that the lower record covers a longer time than the other.

The accompanying diagram presents in condensed form the results of some thousands of calculations.



EVOLUTION IN LEAVES.

BY MRS. W. A. KELLERMAN, MANHATTAN.

Even the most casual observer could not fail to notice the general variation in the foliage of plants; that the various herbs, shrubs and trees bear leaves stamped with an individuality of their own. Anyone would be able to distinguish between

the leaves of the rose and those of the oak. But besides the difference existing between orders, genera and species, there is also often a marked variation in the leaves of one and the same plant; and it is this particular phase of variation to which I wish to call attention.

One of the most familiar plants which furnishes an illustration of this variation among its individual leaves is rubus villosus, common high blackberry, which usually has from three to five leaflets arising from a common point on the footstalk. But many of the leaves do not answer to this description. As will be seen by referring to figures 1–11, the two lower leaflets are often found to be more or less lobed in the trifoliate leaves. Upon closer examination, such a prodigious number of leaves exhibited this peculiarity that I was led to consider them as representing *transition stages* between three and five leaflets. The highest type of the present seems to be five leaflets, and the threes appear to be struggling to reach that number. To make sure that the leaves first observed were not "freaks of nature," or from a botanical standpoint, monstrosities, the whole neighboring region was explored, and everywhere the blackberry leaves exhibited indications of this peculiarity, which I have chosen to designate as an *evolutionary tendency.* The first indication of the division or transition of a leaf, according to my observations, is an enlargement on the portion of the leaf where the division is about to take place; further on in the series, this enlargement becomes a conspicuous bulge, as shown in figure 6, and the vein which is to form the midrib of the newly-formed leaflet becomes strong and prominent; a notch is next formed, which deepens into a lobe, and finally the entire leaflet is given off, as shown in figures 7, 8 and 9. For instance, in the trifoliate leaves of the blackberry, the enlargement will be found on the lower part of the two lateral leaflets, then the various stages of division, resulting finally in the five leaflets. Single leaves were also found in process of division into three leaflets, and two specimens were found bearing six leaflets; one in which the terminal leaflet had thrown off an additional leaflet, and the other with the extra leaflet given off from one of the lowest lateral leaflets. (Figs. 10–11.) My attention being aroused in this direction, I now noticed in very many plants similar transition stages. The ampelopsis quinquefolia, Virginia creeper, afforded numerous illustrations. The normal number of leaflets, as the name indicates, is five, but the transition from five to six and seven leaflets was noted in very many cases; first, an enlargement was observed on the lower or outer portion of the lower leaflets, then a notch, which set forth. One should be able to find transition stages in the cinquefoil; *i. e.*, cases where the division into five leaflets was still in process.

Carlyle says, "How few people think; aye, reader, how few people think"; and we may add, how much there is which we fail to see. How many times before I had examined and admired the leaves of this potentilla, and yet had never appreciated the embryonic history of evolution stamped upon it, for it still retains the single leaflet, perhaps the ancestral type, and transition forms from one to five leaflets are readily found. All pinnate leaves which were observed, except those of the rose, continue to form new leaflets by a division of the terminal leaflet; deepened as the series continued, until the seven perfect leaflets were formed. The Rhus Toxicodendron, Poison Ivy, is so often spoken of in contradistinction to the ampelopsis quinquefolia, that a study of its leaves was next made. The Rhus Toxicodendron commonly has three more or less entire leaflets, though they are often sinnate or cut-lobed. A number of specimens were found where the lower leaflets had thrown off another pair, making it five-leaved. The tendency, however, seems to be to develop toward nine leaflets rather than five, each of the three leaflets becoming trifoliate. Potentilla Canadensis, the common cinquefoil, next claimed my attention. According to the ideas here, when a new leaflet is about to be formed the terminal leaflet will often

appear to be over-grown, and the outline of the perfect leaf is frequently plainly discernible before the division is complete. (Figs. 25–29.) It is also interesting to observe that often where a new leaflet has been added, a corresponding notch seems to have been cut from the parent leaf. (Figs. 25 and 28.) Then another leaf is thrown off from the opposite side, taking out a similar notch, thus rendering the terminal leaflet again normal and symmetrical. Lambucus Canadensis, the common Elder, shows remarkable respondence to favorable conditions in the increase of its leafage. The plain pinnate leaves are becoming doubly pinnate, and the minute point at the base of the leaflet sometimes also develops into a considerable leaflet. The leaves of Negundo aceroides, Box Elder, furnish numerous examples of this tendency toward a numerical increase of leaflets. It is not at all unusual to find a graduated series, from one to eleven leaflets. The development of the leaflets of the rose, as stated, proved to be an exception to the plan followed by other pinnate leaves, as far as I could find. For a long time search for transition stages was made in vain, when one day while examining the foliage of some tender new shoots, I found the baby leaves in their cradles, as it were. Grant Allen says: "It is the same with plants as with animals; they all pass through a first simple shape, which helps us to picture to ourselves what they once were, so that one of the best ways to discover lost links in the pedigrees of plants, is to watch the development from the seed. The cotyledons, or seed-leaves," he says, "preserve for us still the extremely plain ancestral form, and are the central point from which every variety of foliage first set out." Young shoots may, perhaps, pass through phases of ancestral forms. Those of the rose certainly seem to indicate that such is the case. When a rose leaf is plucked from the stem two stipules will be noticed at the base of the leaf, and strange to say, these stipules seem to be the little mother-leaves, for the leaflets appear to have originated from them. On young shoots the stipules will often be found to be larger than upon the old wood, and if careful examination is made many may be found having a more or less leaf-like form. The upper part of the stipule often assumes the shape and size of the rose leaflet, so that an apparently perfect leaflet is often found still adnate to the stipule; still clinging to it, so to speak, as if loth to be alone in the world. Further development is indicated by the division or separation of the leaflet from the stipule, and as the division continues and new leaflets are thus added, the rachis elongates to make room for the new-comers. (Illustrated by figs. 12–20.) Very many specimens were found, illustrating all stages of division from the stipules. Besides this peculiar manner of increasing the number of leaflets, a few specimens were found in which additional leaflets appear to have been quite irregularly added at the base of the leaflets. No transition stages were found in this case—simply the perfect leaves, as seen in the fourth leaf of four-leaved clover.

Leaves in process of evolution seemed calling for recognition on every side. In the fields and woods, along the road-sides, in the flower-bed and the vegetable garden—everywhere interesting specimens were found. The leaves of the cultivated dahlia and those of the potato, tomato and bean all illustrate this tendency. On very many plants where entire leaves ordinarily obtain, notched or obviously-lobed leaves are often found. Examples of such frequently occur on *symphor icarpus racemosus* (snowberry). Again, on plants bearing slightly lobed leaves many are found quite deeply and conspicuously lobed. An interesting example is furnished by the leaves of the wild grape (shown in figs. 30, 38). *Cimicifuga racemosa*, which has decompound leaves, furnishes a good illustration of both partial and complete division. It is extremely interesting to observe the symmetry which obtains in the various leaf divisions. The mother-leaf, so to speak, usually gives off a new leaf on one side, then appears to husband her energies until she is able to form a correspond-

ing leaf on the opposite side; but it is during this unsymmetrical condition that the investigator finds the key to their manner of division or increase (figs. 25–29). It should be borne in mind, however, that the idea is not meant to be conveyed that this division of leaves takes place during a single season—*i. e.*, it is not meant that the individual leaf or leaflet undergoes this entire evolutionary division during a single season. Various stages of division may be found on one and the same plant at the same time, but only a very slight advance on the previous year is made by succeeding years. Slowly, but surely, heredity transmits this tendency to succeeding generations. So numerous and various are the plants exhibiting this proclivity toward division, that one is led to inquire, *Why* this tendency in leaves to divide?

Grant Allen, in his delightful little book on "Flowers and their Pedigrees," says: "Leaves depend for their growth upon air and sunlight; they must be supplied with carbonic dioxide to assimilate, and solar rays to turn off the oxygen and build up the carbon into their system. In open fields or bare spaces, big leaves like burdock or rhubarb can find food and space, but where carbonic dioxide is scarce, and light is intercepted by neighboring plants, all the leaves must needs be fine and divided into almost thread-like segments. The competition for carbon under such circumstances is exceedingly fierce." For example, he continues, "in water only very small quantities of gas are dissolved, so that all submerged water plants have extremely thin waving filaments instead of flat blades, . . . while hedge-row weeds which jostle thickly against one another have a constant hard struggle for the carbon and sunshine, and grow out accordingly into numerous subdivided leaflets, often split up time after time into segments and sub-segments of the most intricate sort."

Sir John Lubbock, in his little book on "Flowers, Fruits, and Leaves," offers a somewhat different explanation. Taking the position of the leaves, the direction of the bough and various other elements into consideration, he says "it seems clear that there is a correspondence between thickness of stem and size of leaf. This ratio, moreover, when taken in relation with the other conditions of the problem, has a considerable bearing, not only on the size, but also on the form of the leaf." Lubbock also accounts for the minute dissection of submerged aqueous plants on the same principle. "We know," to use his own words again, "that the gills of fish consist of a number of thin plates which, while in water, float apart, but have not sufficient consistence to support even their own weight, much less any external force, and consequently collapse in air. The same thing happens in thin, finely-cut leaves. In still water, they afford the greatest possible extent of surface with the least expenditure of effort in the formation of skeleton. The conditions of still air," Lubbock continues, "would approximate those of water, except so far as they are modified by weight, and the more the plant is exposed to the wind, the more it would require strengthening, hence perhaps the fact," he concludes, "that herbs so much oftener than trees have finely-cut leaves."

Of the two views presented, those of Grant Allen seem the more plausible. Heat and light are certainly the great forces which impel the vegetable world; in order to grow, plants must have air and sunlight, and it seems clear that both air and sunlight will come in contact with a greater leaf-surface when the leaves are much cut up or divided than when they are large. The air and light would pass more freely about, among and over the smaller leaves, and a greater number would receive a portion of these necessities of plant-life.

The element of strength suggested by Lubbock, may also play a part in determining the size and shape of leaves, but it may be viewed from another standpoint perhaps equally plausible. Instead of those plants which are weakest and less exposed being divided because they need less frame-work or skeleton, may it not be a method of adaptation which enables them to withstand wind and storm? Small leaves, or those which are much divided, certainly offer *less* resistance to wind and

storm; for the wind would pass more freely through them, and less injury would be likely to result from breakage or mutilation. This would be more emphatically true in the case of submerged water plants. The finely-dissected foliage would offer less resistance to the passage of water through it; it would sway in unison with the motion of the water, and the injury would certainly be reduced to a minimum, while if the leaves were large it seems obvious that they would be more or less mutilated or injured by the action of the water.

It has been suggested that this tendency towards division might, in part at least, be referable to the agency of insects. The large leaves not only offer more food in compact space, but also afford good standing-ground for the insects while feeding; besides, leaf-rollers could make better use of large leaves than finely-divided ones.

With a view of determining whether this suggestion has any foundation in fact, I prepared a list of the commonest plants in the immediate vicinity of Manhattan that bear large leaves, comprising the following genera:

Æsculus.	Circis.	Plantago.	Scrophularia.
Arctium.	Cucurbita.	Platanus.	Sicyos.
Asimina.	Datura.	Polyginatum.	Smilax.
Cacalia.	Echinocystis.	Populus.	Tilia.
Catalpa.	Eupatorium.	Quercus.	Vitis.
Celastrus.	Menispermum.	Rumex.	Xanthium.
Celtis.	Morus.	Sagittaria.	

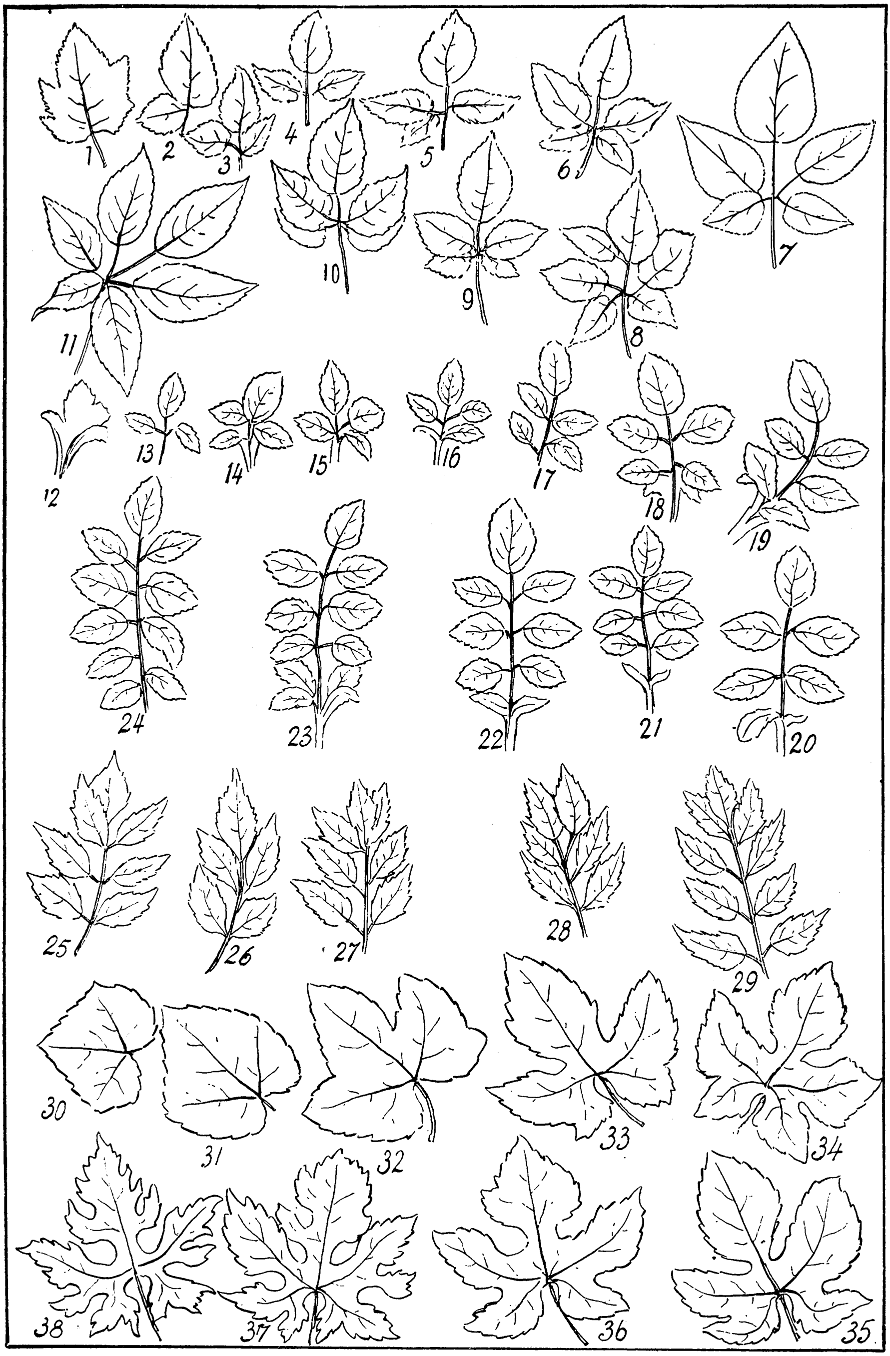
Another list was made of plants in the same region, with very small leaves, or the blades of which were much divided. This second list included the following genera:

Acer.	Cassia.	Houstonia.	Robinia.
Achillea.	Delphinium.	Hymenopappus.	Rosa.
Aquilegia.	Desmanthus.	Leptocaulis.	Salix.
Ambrosia.	Ellisia.	Lygodesmia.	Schrankia.
Amorpha.	Galium.	Lythrum.	Symphoricarpus.
Artemisia.	Geranium.	Melilotus.	Thalictrum.
Astralagus.	Hibiscus.	Pronalea.	

These two lists were handed to an entomologist, with the request that he enumerate the species of insects reported as attacking the several species belonging to the genera. An examination of the enumerated lists revealed the fact, that in case of some of the genera not a single insect while in others as many as twenty insects have been reported as attacking the plants.

The total number of insects on the plants with large leaves was 104. The total number on the plants with small leaves was 152; but, before proceeding further, it may be well to say that the genus *Quercus* was at first included in the list of large leaves, but was subsequently rejected. For this exclusion there seemed to be two, perhaps, sufficient reasons: First, while in some of the oaks the leaves are large and full, in many others they are comparatively small or the blade is cut into medium-sized or small segments. In the second place, only two species of oaks (*Q. primoides* and *Q. macrocarpa*) are very abundant, and three others, (*Q. nigra*, *Q. rubra*, and *Q. tinctoria*,) moderately abundant in the region which furnished the genera of the foregoing lists; and it is evident that of the 117 species of insects reported on the oak, a comparatively few of them should be credited to this district. As stated above, the plants with large leaves harbor *less* instead of more insects than those with the small leaves, as was suggested. That plants with small leaves should harbor a greater number of insects might possibly be explained by reference to the fact that the smaller leaves are usually somewhat more tender, at least have a lighter or less woody framework or skeleton, and therefore, perhaps, furnish more enticing food for insects.

In closing, it may then be remarked that the supposition that the present forms of leaves are both the former and the ultimate ones, is entirely erroneous. Paleontology demonstrates the fact of a long history of a gradual change of forms, and the study detailed above suggests what is going on now. The future forms, therefore, will be the resultant of the environment acting on these variable organs.



EXPLANATION OF PLATE.

Figs. 1–11. Leaves of common blackberry, showing mode of variation from a simple to a 6-foliate leaf.

Figs. 12–24. Leaves of the rose, illustrating developments of leaflets from the stipules.

Figs. 25–29. Leaves of trumpet creeper, illustrating the mode of numerical increase of leaflets by a division of the terminal leaflet.

Figs. 30–38. Leaves of wild grape, showing the variation from the entire to the deeply-lobed leaf.